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THE TUBERCLE BACILLUS IN MILK.*

GUTHRIE MCCONNELL.
(From the Bacteriological Laboratory, State Board of Health of Missouri, St. Louis, Mo.)

ALTHOUGH the question as to the degree of danger of infection by bovine tuberculosis is a mooted one, nevertheless there can be no hesitation in acknowledging that the purer the milk supply the better protected is the health of the community. Milk that contains bovine tubercle bacilli is not as wholesome a food as that which is free from them, but if they are to be present it is better that they should be dead than living.

About a year ago a few investigations were made concerning the milk supply of the city of St. Louis and the results that were obtained were both interesting and in a way satisfactory.

According to the experiments of Rosenau[1] it was shown that the tubercle bacillus in milk loses its infective properties for guinea-pigs when heated to 60° C. and maintained at that temperature for 20 minutes, or to 65° C. for a much shorter time. To quote further, it should be remembered that the milk in these tests was very heavily infected with virulent cultures, as indicated by the prompt death of the control animals. Under natural conditions milk would practically never contain such an enormous amount of infection. It is justifiable to assume that if 60° C. for 20 minutes is sufficient to destroy the infectiveness of such milk when injected into the peritoneal cavity of a guinea-pig, any ordinary market milk after such treatment would be quite safe for human use by the mouth, as far as tubercle bacilli are concerned.

In commercial practice the above results are sought for in a different way. Prolonged heating of milk even at comparatively low temperatures produces certain changes that may interfere to some extent with its value as a food. Another consideration is that of the practical impossibility of uniformly heating the large quantities of milk that are handled by the larger dealers. The result is that the larger companies make use of that form of pasteurization known as the "flash" method. Various forms of apparatus have been devised for this

* Received for publication February 26, 1909.

[1] *Bull. No. 42, Hyg. Lab.*, U. S Pub. Health and Mar. Hosp. Ser., 1908

purpose but the principle in most of them is more or less the same. The milk is allowed to pass upon a rapidly turning plate, the centrifugal force spreading the milk in an extremely thin layer, less than $\frac{1}{200}$ of an inch at the periphery. Under this disc is a hot-water chamber kept at the proper temperature by means of steam jets. The extreme thinness of the film of milk permits it to be heated to a high point almost instantaneously. The milk then passes over plates cooled by brine and goes on to the receiving tank, the entire process taking from 30 seconds to one minute. The degree of heat employed is in the neighborhood of from 70° to 80° C., or slightly lower if the exposure is to be longer.

All of the larger dealers make it a common practice to pasteurize their milk during the winter as well as the summer months so that there is no time during the year when the milk is not so treated.

On February 1, 1908, the following experiments were made, the idea being that of testing some milk as it was brought into the city and then other samples of the milk as they were distributed. The first sample was obtained from the can just after the milk train arrived in the city. This specimen came from a lot of three cans that contained the milk from one small farm. The second, obtained at the same time, was from a lot of some 30 cans that came from a general station where milk from numerous sources was received in bulk. A third specimen was taken at a dairy from a tank holding some 800 gallons, about one-half of which had been once pasteurized but had been mixed with nearly an equal amount of raw milk. The material in this tank represented milk that had come from many different farms and consequently hundreds of different cows. The fourth specimen was the same as No. 3 after it had passed through the commercial flash pasteurizer.

About a quart of milk was taken as a sample, this being centrifuged as soon as it reached the laboratory. Those samples from the train cans contained quite a large amount of sediment but those from the dairy had but little. This sediment was diluted with the respective milk and then portions were injected, subcutaneously, into the abdominal wall of each of four guinea-pigs in each experiment. Each set of guinea-pigs was kept in its separate cage and all under the same environment. The following tables show the results.

TABLE 1.

RAW MILK FROM ONE SOURCE.

	2.1.'08	2.8.'08	2.21.'08	3.4.'08	3.10.'08	Autopsy
A.	270 gm.	240 gm.	Died 2.18.'08.		Weight 215 gm.	Negative
B.	280 "	250 "	335 gm.	350 gm.	380 gm.	"
C.	260 "	230 "	310 "	320 "	390 "	"
D.	390 "	370 "	480 "	510 "	540 "	"

In this series Pig A lost weight and died in 17 days but no macroscopic lesions were found. The other pigs showed no changes when chloroformed some six weeks later.

TABLE 2.

RAW MILK FROM SEVERAL SOURCES.

	2.1.'08	2.8.'08	2.21.'08	3.4.'08	3.10.'08	Autopsy
A.	360 gm.	365 gm.	430 gm.	470 gm.	460 gm.	Enlarged nodes
B.	290 "	280 "	310 "	360 "	380 "	Negative
C.	310 "	350 "	410 "	460 "	490 "	"
D.	280 "	Died 2.4.'08.				

In this series pig A, which was chloroformed about six weeks after the injection, showed several enlarged lymph nodes under the jaw in the region of the trachea. On the left side there was a node about 2 cm. in diameter; other adjacent nodes were enlarged but not to the same extent. No lesions were found in the abdominal or pleural cavities.

Pig D died three days after the inoculation.

TABLE 3.

ONE-HALF RAW, ONE-HALF PASTEURIZED MILK.

	2.1.'08	2.8.'08	2.21.'08	3.4.'08	3.10.'08	Autopsy
A.	310 gm.	290 gm.	350 gm.	395 gm.	430 gm.	Negative
B.	400 "	390 "	420 "	470 "	500 "	Enlarged nodes under chin
C.	370 "	400 "	460 "	480 "	525 "	" " " "
D.	320 "	360 "	360 "	390 "	440 "	" " " "

Pig A. showed nothing abnormal by the end of six weeks.

Pig B (3.14.'08) on the right side of the neck under the chin presented an enlarged node about 2 cm. long and 1 cm. in diameter. Several other nodes, smaller than the above, but nevertheless enlarged, were found. Two somewhat enlarged bronchial nodes were found on the right side. Pleural and peritoneal cavities negative.

Pig C (3.13.'08): Tracheal nodes enlarged to size of cherries. At the site of the injection into the abdominal wall there was a swelling about 0.5 cm. in diameter free from hair and filled with a thick caseous material. Bronchial nodes were enlarged. In the right lung there was a small yellowish area. No lesions in the abdominal cavity.

Pig D (3.14.'08): On the left side under the chin there was present an enlarged node about 1 cm. long by 0.5 cm. thick. On the right there was a somewhat smaller node. No lesions were found in either the pleural or peritoneal cavities.

TABLE 4

PASTEURIZED MILK.

	2.1.'08	2.8.'08	2.21.'08	3.4.'08	3.10.'08	Autopsy
A.	340 gm.	340 gm.	370 gm.	375 gm.	400 gm.	Negative
B.	225 "	250 "	280 "	300 "	340 "	"
C.	280 "	290 "	300 "	285 "	320 "	"
D.	260 "	270 "	280 "	280 "	310 "	"

Pig A was chloroformed some six weeks after the inoculation (on 3.13.'08).

Pigs B, C, and D four days later than the above. In no instance was anything abnormal found at the site of the inoculation, in the pleural or in the peritoneal cavities.

Whenever enlarged nodes were present they were found to consist of a rather dry caseous mass contained within a thin capsule apparently composed of connective tissue and a narrow zone of lymphoid tissue.

The results in these series seem to follow a fairly logical course. In Series 1 where the milk was obtained from a single source none of the pigs showed any lesions. This could easily be explained on the basis that that particular herd was free from tuberculosis.

In Series 2 the raw milk came from several sources, in this way permitting the larger mass of milk to become contaminated by infected material from some one source. In this we find one of the three guinea-pigs involved. The fourth pig, dying within three days after the inoculation, has to be omitted.

Series 3 shows what naturally might be expected, when the number of sources from which so large a quantity of milk is obtained is taken into consideration. In this instance a comparatively small amount of infected matter would be able to pollute the larger mass. In this series three out of the four pigs showed marked involvement of the lymph nodes of the neck.

In Series 4 where pasteurized milk was employed none of the four pigs showed lesions.

Although the number of experiments is small yet it would seem to bring out two points of interest. The first, which is very evident, is that the greater the number of sources from which the milk is derived the greater the likelihood of infection by tuberculosis. The second, that commercial pasteurization by the flash method, when properly carried out, is sufficient to destroy the organism of tuberculosis.

The question as to the thermal death-point of the tubercle bacillus is thoroughly discussed in the article by Rosenau. The early investigators thought that the tubercle bacillus was a spore-producer and was able to withstand very high degrees of heat. As methods became more exact and observers more accurate in their conclusions it was found that the tubercle bacillus could be destroyed by comparatively low temperatures after short exposures. Six observers besides Rosenau report the death of tubercle bacilli after an exposure to 60° C. for 20 minutes. Russell and Hastings[1] showed that material exposed in a continuous-action pasteurizing machine to 71°.1 C. for one minute was freed from living tubercle bacilli.

[1] *21st Ann. Rep.*, Univ. of Wisconsin Agri. Exper. Sta., 1904.